

NOTES & CORRESPONDENCE

HERTZ AND THE TECHNOLOGICAL SIGNIFICANCE OF ELECTROMAGNETIC WAVES

*By Charles Süsskind **

On reviewing the manuscript of my monograph on the origins of radiotelegraphy,¹ a British colleague — a Fellow of the Royal Society who had studied in Germany — asked me whether I knew that Heinrich Rudolf Hertz (1857–1894) had, on his death bed, stated that he did not think that the electromagnetic waves whose existence he had confirmed would ever be of any technological significance. I had heard the anecdote before, though in less elaborate form and never from so well-qualified a source, and I now determined to track down the story.

Its first appearance evidently dates back to the publication of an early text on radiotelegraphy by Karl Friedrich Braun (1850–1918), the inventor of the cathode-ray tube, in 1901:

Schon im Jahre 1889 erhielt HERTZ vom Civilingenieur HUBER in München die Anfrage, ob sich seine Wellen nicht zu einer drahtlosen Telegraphie würden verwenden lassen. HERTZ verneinte die Frage. Wäre sie zwei Jahre später an ihn ergangen, vielleicht hätte er sie bejaht.²

As early as 1889, Hertz was asked by an engineer in Munich, Huber, whether his waves could not be employed for wireless telegraphy. Hertz answered in the negative. If the question had been put to him two years later, perhaps his answer would have been in the affirmative.

The English literature on the subject echoes this view. In another early account, Story says: “Huber questioned Hertz as to the possibility of making use of the electro-magnetic waves as a means of telegraphing without wires. Hertz threw cold water on the idea. He had not grasped the full significance of his own discovery.”³

Huber’s letter and Hertz’s reply are preserved in the Deutsches Museum in Munich. In 1930, Appleyard published a photographic reproduction of the letter, together with a rather inaccurate translation, and added the following comment:

It can be definitely stated that concerning the future employment of Hertzian waves for telegraphy and telephony he had no premonitions. For there exists a letter written by him to one, Herr Huber, who wanted to know whether

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¹ Charles Süsskind, *Popov and the Beginnings of Radiotelegraphy* (San Francisco: San Francisco Press, 1962).

² K. F. Braun, *Drahtlose Telegraphie durch*

Wasser und Luft (Leipzig: Veit & comp., 1901), p. 15. English translations have been made by the author of this article.

³ A. T. Story, *The Story of Wireless Telegraphy* (London, 1904).

there was a prospect in that direction. Hertz regarded it as impracticable. His reply, which is reproduced in Fig. 13, was to the effect that the application of such a mode of electrical communication to practical telegraphy or telephony would need a mirror as large as a continent.⁴

Further evidence that the story continues to have literary currency appears in the biographical collection *Die grossen Deutschen*. Max Theodor Felix von Laue (1879–1960), who contributed the article on Hertz, wrote in 1957 that Hertz “himself never gave a thought to the technological utilization” of his waves (*an deren technische Verwendung er selbst nie gedacht hat*).⁵

The simplest way to set the record straight is to quote Huber’s inquiry and Hertz’s reply in original and in English translation.

Huber to Hertz, 1 December 1889:

Schon von verschiedenen Seiten habe ich von Ihren grossartigen Erfolgen auf dem Gebiete der Electricitätslehre gehört ohne aber genau erfahren zu haben, um was es sich speciell handelte. Heute erst komme ich in die glückliche Lage einige Details zu erhalten & mir genauere Aufklärung durch Ihre Originalberichte zu verschaffen. Meine Hochachtung Ihnen gegenüber, Herr Professor, ist eine so grosse, dass *ich* es gar nicht wage, Ihnen von Herzen Glück zu Ihren weittragenden Entdeckungen zu wünschen; denn der Unterschied ist ein zu grosser. In Nachstehendem erlaube mir nur eine Frage an Sie zu stellen, mit der höfl. Bitte um gelegentliche gefl. Beantwortung durch einige Zeilen.

Es würde mich sehr interessiren zu hören, ob es nicht auch möglich wäre, nach Ihrer Theorie, die magnetischen Kraftlinien (die unsichtbaren natürlich) in die Ferne zu übertragen? Ich habe hier Transformatoren & das Telephon in erster Linie in Betracht gezogen.

Auf der einen Station würde z. B. im Brennpunkte eines Hohlspiegels ein Pol eines Electromagnets erregt. Die magnet. Linien (das magnet. Feld) werden dann vom Spiegel der andern Station aufgenommen & erzeugen mit

I had previously heard from various sources about your magnificent successes in the field of electrical knowledge, but without having learned exactly what the particular subject was. Not until today do I find myself in the fortunate position of having obtained some details and of having achieved more exact understanding through your original reports. My respect towards you, Sir, is so great that *I* do not even dare to wish you luck with all my heart in your far-reaching discoveries; for the difference between us is too great. In the following, I take the liberty of putting only one question to you, with the respectful request that you might favor me with a few lines in reply at your convenience.

I should be very interested to hear whether it would not be possible, according to your theory, to transmit the magnetic lines of force (the invisible ones, of course) over a distance? I am thinking in the first instance of transformers & the telephone.

One could, for instance, excite a polepiece of an electromagnet at the focal point of a convex mirror. The magnetic lines (the magnetic field) are then received by the mirror of the second station & produce induction (sec-

⁴ Rollo Appleyard, *Pioneers of Electrical Communication* (London: Macmillan, 1930), p. 140.

⁵ Herrmann Heimpel, ed., *Die grossen Deutschen* (Berlin: Propyläen-Verlag, 1957), Vol. 4, pp. 103–112.

Benützung einer Inductionsspule In-
ductions- (secundäre) Ströme.⁶

ondary) currents by means of an induc-
tion coil.

The letter, which was sent to Hertz in Bonn from the Netherlands, is signed "Heinrich Huber aus München, Elektriker." It contains a sketch of two facing parabolic mirrors, one with the top of an electromagnet at its focal point and the other, an air-core coil. There is no mention of telegraphy (let alone "wireless" telegraphy) whatsoever. Huber, who was employed at the power station that provided The Hague with electric light, manifestly had only electric power and the telephone in mind.

Hertz replied immediately.

Hertz to Huber, 3 December 1889:

Auf Ihre freundlichen Zeilen vom 1 ds antworte ich ganz ergebenst das folgende: Magnetische Kraftlinien lassen sich ebenso gut wie die elektrischen als Strahlen fortpflanzen, wenn ihre Schwingungen nur schnell genug sind, denn in diesem Falle gehen sie überhaupt mit den elektrischen zusammen, und die Strahlen und Wellen um welche es sich in meinen Versuchen handelt könnte man ebenso gut magnetische als elektrische nennen.

Aber die Schwingungen eines Transformators oder eines Telephons sind viel zu langsam. Nehmen Sie tausend Schwingungen in der Sekunde, was doch eine hohe Zahl ist, so würde dem doch im Aether schon eine Wellenlänge von 300 Kilometern entsprechen, und von der gleichen Grössenordnung müssten also auch die Brennweiten der benutzten Spiegel sein. Könnten Sie also Hohlspiegel von der Grösse eines Continents bauen, so könnten Sie damit die beabsichtigten Versuche sehr gut anstellen, aber praktisch ist nichts zu machen, mit gewöhnlichen Hohlspiegeln würden Sie nicht die geringste Wirkung verspüren. So vermuthe ich wenigstens.⁷

In regard to your friendly lines of the 1st inst. I beg to reply as follows: Magnetic lines of force can be propagated as rays just as well as electric lines as long as their oscillations are sufficiently fast, for in that case they altogether coincide with the electric lines, and the rays and waves that occur in my experiments could be equally well called magnetic as electric.

But the oscillations of a transformer or a telephone are much too slow. Take a thousand oscillations per second, which is surely a high figure, yet the corresponding wavelength in the aether would be 300 kilometers, and the focal lengths of the mirrors employed would have to be of the same order of magnitude. If you could thus build convex mirrors as large as a continent, you might very well be able to set up the proposed experiments, but in practice nothing can be done, you would not perceive the slightest effect with ordinary convex mirrors. At least that is what I suppose.

⁶ MS No. 2939, Deutsches Museum, Munich.

⁷ MS No. 573, Deutsches Museum, Munich. Appleyard's translation (*op. cit.*) renders *eines Transformators oder eines Telephons* as "of a

'Transformator' or telegraph" and omits the final sentence; the substitution of "telegraph" for "telephone" and the omission of the mild disclaimer serve to compound the confusion.

This reply is technically flawless. The proposal was to propagate electromagnetic waves at audio frequencies, and Hertz quite rightly pointed out that they would not propagate and that antennas of stupendous size would be in any case required for their generation. The various technical solutions of the problem, such as detection of the keying or of low-frequency modulation of a high-frequency carrier, which led to radiotelegraphy and radiotelephony, did not come until after Hertz's death.

Accordingly, the story that Hertz (whose first technical training was in engineering) had no head for practical matters may be safely laid to rest, together with the implication that his reply to Huber delayed the development of radiotelegraphy by several years. First, the above correspondence received no circulation at the time. Second, as I pointed out in my monograph,⁸ at least three other proposals to employ electromagnetic waves for communications were independently made during the following three years, by Richard Threlfall (1861–1932) in 1890;⁹ in an editorial in *The Electrician* in 1891;¹⁰ and by William Crookes (1832–1919) in 1892.¹¹ The first publication to describe a radiotelegraphic system was Marconi's patent application in 1896.¹² Third, it is possible that radiotelegraphy might have developed independently, from the efforts of the inventors whose observations of electromagnetic-wave propagation before Hertz I described in a recent paper.¹³

There is a curious postscript to the story. In 1906, the Deutsches Museum authorities corresponded with Huber (then back in Munich) to establish whether he was the one who had written the letter to Hertz, which his family had contributed to the Museum's manuscript collection. Huber confirmed that he was their man,¹⁴ and added that the primitive experimental configuration that he had proposed "for wireless telegraphy and telephony" derived from the discoveries that had been made in 1879 by David Edward Hughes (1830–1900). He went on to cite the extract from Braun's book that I have quoted.¹⁵

However, the observations that Hughes made in 1879 were not published until 1899, ten years *after* Huber's correspondence with Hertz, as I noted in the above-mentioned paper;¹⁶ until then, Hughes' observations were known only to a handful of his colleagues in the Royal Society, men with whom Huber could scarcely have had any contact. It would thus appear that Huber, whose memory had evidently played him the familiar trick of reversing the sequence of two events (his letter to Hertz and his reading about Hughes' experiments a decade or more later), was himself an early victim of the false belief that he had proposed radiotelegraphy to Hertz and had received a "wrong" answer.

⁸ Susskind, *op. cit.*

⁹ Richard Threlfall's presidential address, *Report of the Australasian Association for the Advancement of Science*, 1890, 2:27–54.

¹⁰ Unsigned editorial, *Electrician*, 1891, 26: 685. The editor at that time was A. E. Trotter (1857–1947).

¹¹ William Crookes, "Some Possibilities of Electricity," *Fortnightly Review* (London),

1892, 51:173–181.

¹² British Patent No. 12,039; 1896.

¹³ C. Süsskind, "Observations of Electromagnetic-Wave Radiation Before Hertz," *Isis*, 1964, 55:32–42.

¹⁴ MS No. 572, Deutsches Museum, Munich.

¹⁵ Braun, *op. cit.*

¹⁶ Süsskind, "Observations of Electromagnetic-Wave Radiation Before Hertz."